

REMARKS

The Advisory Action dated June 29, 2004 has been carefully considered.

Status of the Claims

Claims 1-29 are pending. Claim 2 is canceled. Therefore, claims 1 and 3-29 remain in the current prosecution.

Claims 1 and 4 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. Claims 1 and 4 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite.

The Examiner maintains the rejection of the claims, as stated in the Office action dated April 22, 2004. Specifically, claim 1 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Boudreaux et al. (U.S. Patent 4,104,605; hereinafter "Boudreaux"). Claims 1 and 3 are rejected under 35 U.S.C. § 103(a) as being unpatentable over the article by Budhani et al., entitled "Thin Film Temperature Sensors for Gas Turbine Engine: Problems and Prospects" (hereinafter "Budhani"). Claim 2 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Boudreaux in view of JP 410034825A (hereinafter "JP '825"). Claims 5, 8-11, 13-18, 23, and 25-27 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Budhani in view of JP '825. Claims 6, 7, and 24 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Budhani in view of JP '825, and further in view of EP0908713A1 (hereinafter "EP '713"). Claim 19 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Budhani in view of JP '825, and further in view of prior art disclosed on page 8 of specification. Claims 20-22 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Budhani in view of JP '825, and further in view of Smialek et al. (U.S. Patent 5,275,670; hereinafter "Smialek"). Claims 28 and 29 rejected under 35 U.S.C. § 103(a) as being unpatentable over Budhani in view of JP '825, and further in view of Chapman et al. (U.S. Patent 6,568,848; hereinafter "Chapman").

The Examiner refuses to enter the Applicants' amendments of June 9, 2004 for the alleged reason that they raise new issues.

The Applicants hereby respectfully request that the Applicants' amendments and remarks dated June 9, 2004 be entered. In addition, the Applicants respectfully request that the current amendments and remarks also be considered.

Japanese Reference JP 410034825A Does Not Teach The Same Thermal Strain Recited in Claims 1, 3, 5-11, and 13-29

The Advisory Action states that the Applicants' "argument [that JP'825 teaches a different concept of strain] is not persuasive because the Examiner only uses JP, as a secondary reference, for its teaching that the thermal strain of 0.006 can be provided between two material if desired." The Applicants respectfully traverse this statement because (1) JP '825 does not teach a thermal strain that is positive but less than about 0.006, as recited in amended claims 1, 5, 10, 17, 25, 26, and all claims dependent therefrom; and (2) even if a reference is used as a secondary reference under a Section 103(a) rejection, the combination of that reference with the primary reference still must teach or suggest all of the limitations of each of the claims. Therefore, if the secondary reference is used as evidence of the alleged teaching of an element of the claim, the meaning of that element must be the same as that in the claim. Otherwise, the reference does not teach or suggest the same element.

JP '825 teaches a truss structure that has zero strain because the two layers bonded to either side of the truss have opposite expansion coefficients: one positive and one negative. See; e.g., "Method for solution" on page 4 of the enclosed English translation of JP '825; paragraph 0003 on page 7; paragraph 0008 on page 9; and paragraph 0011 on page 10. Thus, JP '825 teaches that a layer having positive thermal expansion is attached to one side of a structure and a layer having negative thermal expansion is attached to the other side of the structure. The opposite expansion of these layers keeps the net strain of the whole unit at zero strain.

In contradistinction, the instant claims do not recite three layers, the two outer layers of which have opposite coefficients of expansions.

Since the concept of strain taught in JP '825 is different from that recited in each of claims 1, 3, 5-11, and 13-29, combinations of JP '825 and one or more other cited references do not teach or suggest all of the limitations of each of these claims. Thus, these claims are patentable over any combination of references that includes JP '825.

In view of the above, it is submitted that the claims are patentable and in condition for allowance. Reconsideration of the rejection is requested. Allowance of claims at an early date is solicited.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Toan P. Vo", is written above a horizontal line.

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(54) [Title of the invention]

Bonding Structure With Low Thermal Strain Of Navigating

Body In Space.

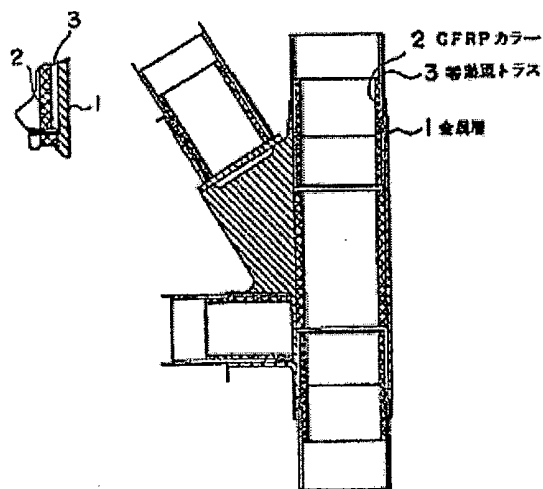
(57) [Summary]

[Topic]

To offer a bonding structure with low thermal strain of a navigating body in space that can control thermal strain to a great extent as compared to the past and can sufficiently lower the error or deviation in sensor orientation axis.

[Method for solution]

In the bonding of zero thermal strain truss 3, metal layer 1 having plus linear expansion coefficient is arranged on surface and CFRP collar 2 having minus linear expansion coefficient is arranged on internal side.



(The Japanese characters in the above figure from top to bottom mean the following.

CFRP collar

Zero thermal strain truss

Metal layer)

[Scope of patent claims]

[Claim 1]

The bonding structure with low thermal strain of a navigating body in space has the characteristic of being an intercalation (between layer) bonding structure of metal layer and CFRP laminate, in which mutual expansion and contraction of metal layer having plus linear expansion coefficient and CFRP layer having minus linear expansion coefficient are cancelled.

[Claim 2]

The bonding structure with low thermal strain of a navigating body in space has the characteristic of arranging metal layer on the external side and CFRP layer on internal

side in the bonding structure that bonds structural components constituting the navigating body in space.

[Claim 3]

The bonding structure with low thermal strain of a navigating body in space described above in claim number 2 in which the structural component constituting the navigating body in space is zero thermal strain truss.

[Detailed description of the invention]

[0001]

[Technical field of the invention]

The present invention relates to the bonding structure with low thermal strain of a navigating body in space such as earth observation satellite etc.

[0002]

[Techniques of the past]

The earth observation satellite structure or accurate observation sensor structure are generally prepared from low thermal strain material such as carbon fiber-reinforced

plastic (CFRP) for controlling the sensor orientation axis error on the orbit to the lowest limit. The bonding part between this low thermal strain material is prepared from Al alloy or Ti alloy.

[0003]

Figure 3 shows bonding part of the past and it aims at lowering the thermal strain as a whole by bonding metal bonding part 5 having plus linear expansion coefficient and CFRP material 6 having minus linear expansion coefficient in parallel.

[0004]

[Problems the invention solves]

The problem number 1 of technique of the past is the boundary of lowering the thermal strain. The reason is that temperature of different parts of navigating body in space should be lowered and raised uniformly and temperature distribution becomes uneven due to shade, sun rays, internal generated heat etc.

[0005]

The earth observation satellite structure or accurate observation sensor structure are becoming highly functional during the recent years and demand for controlling sensor orientation axis error is on rise. On the other hand, size of artificial satellite is increasing and it required more power and therefore, fluctuation in sensor orientation axis by thermal strain is increasing. However, in the technique of the past shown in figure 3, error or deviation in sensor orientation axis cannot be sufficiently controlled.

[0006]

Therefore, the present invention aims at offering a bonding structure with low thermal strain of a navigating body in space that can control thermal strain to a great extent as compared to the past and can sufficiently lower the error or deviation in sensor orientation axis.

[0007]

[Method to solve the problems]

The bonding structure with low thermal strain of a navigating body in space in which metal layer having plus linear expansion coefficient and CFRP laminate collar having minus linear expansion coefficient are arranged on external and internal side of the zero thermal strain truss respectively, can be obtained by the present invention.

[0008]

In the bonding structure with low thermal strain of the present invention, metal layer and CFRP laminate collar cancel the deformation of each other with respect to the change in temperature due to which bonding structure having low thermal strain can be obtained.

[0009]

[State of practicalization of the invention]

The state of practicalization of the present invention has been explained below. Figure 1 shows observation satellite structure in which bonding structure having low

thermal strain of the present invention has been used, and it is an example of truss structure bonding. Moreover, figure 2 shows details of parts of bonding part.

[0010]

Structure of figure 1 is constituted from zero thermal strain truss 3 and truss bonding part 4. The truss bonding part 4 is the part of bonding between the zero thermal strain truss 3 and it is formed from metal layer 1 and CFRP laminate collar 2 as shown in figure 2.

[0011]

The outermost layer of bonding part is metal layer 1 and zero thermal strain truss 3 that is the part to be bonded is bonded in the internal side of this metal layer. Furthermore, CFRP laminate collar is bonded on the internal side of zero thermal strain truss 3 (refer to figure 2). Zero thermal strain truss 3 is the main part forming the truss structure of figure 1 and truss part can be formed from zero thermal strain CFRP laminate structure.

[0012]

This bonding part is formed from integrated bonding structure due to which metal layer 1 having plus linear expansion coefficient and CFRP laminate collar having minus linear expansion coefficient cancel the deformation with respect to change in temperature.

[0013]

Cross section area of metal layer 1 is taken as A_1 , its linear expansion coefficient is taken as α_1 , elasticity coefficient is taken as E_1 , length is taken as l and elongation with respect to temperature difference Δt is taken as Δl . Similarly, in the case of taking material properties of CFRP laminate collar as A_2 , α_2 and E_2 ,

$$\Delta l = \Delta t \alpha_1 l \quad \dots (1)$$

$$\Delta l = P l / E A_1 \quad \dots (2)$$

$P = \alpha_1 E_1 A_1 \Delta t$ from equation (1) and (2) and P is the thermal strain generated in metal layer 1 by temperature difference Δt and for reducing this thermal strain and that of CFRP laminate collar 2, the third element is set as

$$\alpha_1 E_1 A_1 = \alpha_2 E_2 A_2 \quad \dots (3)$$

[0014]

Different elements such as α , E, A of metal layer 1 and CFRP laminate collar are set as per equation (3) and if bonding part linear expansion coefficient α is concretely calculated, then

In case of Al alloy, $\alpha = 1 \times 10^{-7}/^{\circ}\text{C}$ from $\alpha_1 = 22 \times 10^{-6}/^{\circ}\text{C}$

In case of Ti alloy, $\alpha = 1 \times 10^{-7}/^{\circ}\text{C}$ from $\alpha_1 = 7 \times 10^{-6}/^{\circ}\text{C}$

[0015]

Thus, from this structure, structure having zero thermal strain in length direction with respect to temperature can be obtained and zero thermal structure of satellite structure can be obtained.

[0016]

In the state of practicalization of the present invention, truss structure, metal material and CFRP laminate have been explained with examples, however, the present invention can be used for explaining the frame structure and structure

of navigating body in space and it is within the scope of the present invention.

[0017]

In the case of bonding part having different linear expansion coefficients formed from different materials (for example, ceramic and CFRP etc.) and controlling the linear expansion coefficient as a whole, the present invention can be used and it is within the scope of the present invention.

[0018]

[Effect / result of the invention]

Effect number 1 of the present invention is that zero thermal strain can be obtained. Its reason is log calculation of linear expansion coefficient as a whole.

[Brief explanation of figures]

[Figure 1]

Shows observation satellite structure of state of practicalization of the present invention.

[Figure 2]

Shows details of bonding part of figure 1.

[Figure 3]

Shows structure of the past.

[Explanation of symbols]

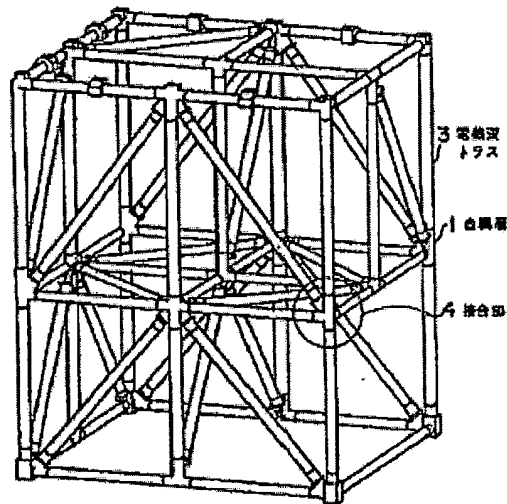
1 Metal layer

2 CFRP collar

3 Zero thermal truss

4 Bonding part

[Figure 1]



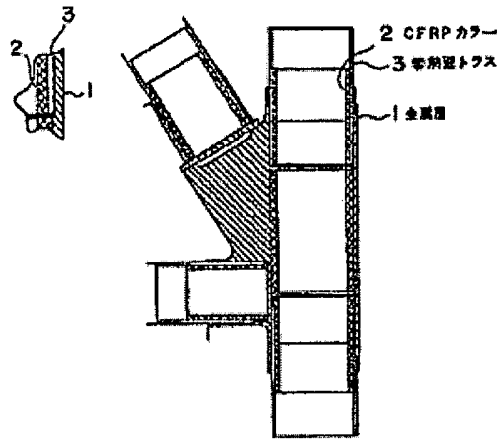
(The Japanese characters in the above figure from top to bottom mean the following.

Zero thermal strain truss

Metal layer

Bonding part)

[Figure 2]



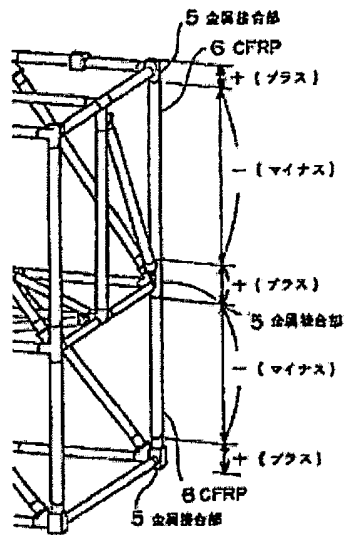
(The Japanese characters in the above figure from top to bottom mean the following.

CFRP collar

Zero thermal strain truss

Metal layer)

[Figure 3]



(The Japanese characters in the above figure from top to bottom mean the following.

Metal bonding part

CFRP

Plus

Minus

Plus

Metal bonding part

Minus

Plus

CFRP

Metal bonding part)